

Para Table Tennis Intensity: Implications for Health and Rehabilitation

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ABSTRACT

Rationale: Sport provides an opportunity for individuals with mobility impairments to potentially meet physical activity intensities associated with positive health outcomes. Para Table Tennis (PTT) is a very popular activity option with limited investigations into the prospective health benefits.

Objectives: The purpose of this study was to document sport intensity across varied conditions of PTT performance. MET values and heart rate were measured in five PTT athletes with mobility impairments across 10 minutes of warm-up, drill, scrimmage, and cool-down conditions on multiple days. The sample sustained an intensity of moderate- to vigorous-intensity exercise across drill and scrimmage activity depending on sport class.

Findings: As a sample, participants sustained an intensity of 8 METs across drill and scrimmage conditions with wheelchair athletes demonstrating a metabolic rate between 3 to 6 METs.

Conclusions: Findings in the current study support the ability of PTT to serve as an exercise stimulus for individuals with mobility impairments.

Keywords

Disability Sport, Energy Expenditure, Metabolic Rate.

To achieve behavior-based health benefits and to mitigate chronic disease risk, the World Health Organization [1] calls for adults with disabilities to engage in 150 to 300 minutes of moderate-intensity aerobic physical activity per week or 75 to 150 minutes of vigorous-intensity. Unfortunately, less than ½ of adults living with mobility impairments meet this threshold which is one factor that explains their increased risk of chronic disease and increased risk of premature death [2,3]. Barriers to meeting this guideline include a number of internal and external factors such as program accessibility, transportation, equipment, and limited exercise knowledge among rehabilitation professionals [4,5]. Fortunately, sport provides an inclusive setting that may enable

individuals with mobility impairments to meet, and potentially surpass, these guidelines. For those who do, associated outcomes include enhanced mental health, increased functional ability, and improved quality of life [6].

Exercise intensity varies widely across sport opportunities for persons with mobility impairments. The Compendium of Physical Activity [7] now includes wheelchair sport, the vast majority of which yield light-intensity thresholds (i.e., 1.5-2.9 METs). Although light-intensity exercise has meaningful impacts on functional ability [8], the cardiometabolic and physiological outcomes are distinct from moderate- or vigorous-intensity levels. Sit skiing (11.8) and wheelchair fencing (7.1) are the only vigorous-intensity sports reported for wheelchair users; however, wheelchair basketball (5.1) and wheelchair tennis (4.1)

are popular sports that both meet the moderate-intensity threshold recommended by the World Health Organization and associated national activity guidelines.

Para table tennis (PTT) is played in over 100 countries internationally and ranks as the third largest sport in the Paralympics Games relative to participants [9,10]. PTT is an inclusive sport played on a regulation table with identical equipment to abled-bodied table tennis. The sport is eligible to individuals across mobility impairment types and athletes are grouped for competition in 5 distinct wheelchair classes, 5 standing classes, and 1 class for athletes with intellectual impairments [11]. PTT athletes report multiple reasons for participating with two primary rationales being an outlet for exercise and a mechanism to improve quality of life [12].

Although multiple studies have investigated skill components of the sport [9,10,13], minimal work has been conducted on energy demand and associated health-related benefits of participation. Based on the recurring intervals of high-velocity movements interspersed with short rest periods [14], it seems possible that this sport could be vigorous in nature; however, reported MET values for table tennis (TT) have only ranged from 4.0 to 2.7 in abled-bodied and wheelchair users, respectively. Because TT is often played as a recreational activity, it is unclear if Para Table Tennis, a competitive sport, meets the World Health Organization guidelines for health-related physical activity. Therefore, the purpose of this study was to document sport intensity across varied conditions of PTT performance.

Methods

Participants

Five participants were recruited from a national PTT team prior to the Paralympic Games. Participants were delimited to athletes with mobility impairments and sample playing experience ranged from 1 to 18 years (median = 13). The majority of participants had been living with their impairment since birth and included two individuals with spinal cord injury (SCI), two individuals with cerebral palsy, and one with dwarfism. Two athletes with SCI participated in the wheelchair classes and the remaining were allocated standing classes. Informed consent was collected prior to participation and all procedures were approved by the University Institutional Review Board (Protocol #24-0947). Descriptive statistics for the sample are found in Table 1.

Instruments

A portable metabolic analyzer (VO2 Master; BC Canada) was used to record oxygen consumption and ventilation data. The VO2 Master portable metabolic system was previously validated against the Parvomedics TrueOne 2400 metabolic cart (Parvomedics, Inc, Salt Lake City, UT, USA), and the publication is available on the VO2 Master website (<https://vo2master.com/blog/category/science/studies/>). Briefly, the validation study found that during exercise, the VO2 Master had a mean absolute difference of <9% for VO2 and <12% for VE [15]. The facemask is a stand-alone unit that is lightweight and does not hinder movement around the

table. Breath-by-breath data were collected and recorded every 30 seconds. A Polar H10 heart rate (HR) monitor (Polar USA, Bethpage, NY) was worn continuously by each participant to monitor HR, which was reported every 30 seconds integrated with the metabolic data. Prior to each testing session, the VO2 Master system was calibrated for air flow and gas exchanges according to the manufacturer's instructions.

Table 1: Athletes' Demographics.

	Variable	Mean	SD
Demographic	Age	25.40	2.07
	Yrs of Exp		
	Yrs with Impairment	22.20	5.90
	Ht (in)	66.60	10.78
	Wt (lbs)	129.00	28.37
Sport Class	Class	# of athletes	
	Men's 3	1	
	Men's 4	1	
	Men's 6	2	
	Men's 9	1	

Table 2: Outcome Measures during PTT.

	Trial 1 (M ± SD)	METs	Trial 2 (Mean + SD)
Rest	1.1 ± 0.2		
WU	6.2 ± 2.3		4.6 ± 1.9
Drills	7.9 ± 3.8		6.3 ± 3.6
Scrimmage	6.5 ± 2.2		5.4 ± 2.3
Cool Down	4.0 ± 1.5		3.6 ± 1.4
		% Max HR	
Rest	72 ± 11.4		
WU	58 ± 12		56 ± 7
Drills	65 ± 15		60 ± 13
Scrimmage	62 ± 14		59 ± 8
Cool Down	52 ± 8		49 ± 6

Procedures

Participants reported to the training facility at 10am on three consecutive days. On day one, participants were familiarized with the VO2 Master mask and Polar HR telemetry strap, followed by 10 minutes of resting metabolic and HR data collection. On days two and three, participants were connected to the VO2 Master mask and Polar HR monitor, and completed 10 minutes each of PTT team warm-up, team drills, and scrimmage. Following each session, 5 minutes of recovery data were collected. Each training session was completed playing with another team member.

Data Analysis

Data were visually inspected and cleaned prior to analysis with several 0 scores removed during connection disruption. Mean MET and heart rate (HR) values were then determined for rest and reported separately for training day by WARM-UP, DRILL, SCRIMMAGE, and COOL-DOWN conditions. Maximum heart rate was estimated from the equation by Tanaka and colleagues to determine percentage of maximum sustained during training conditions.

Results

During PTT, athletes reached and sustained either moderate- or vigorous-intensity exercise (Table 2). As a sample, participants sustained an intensity of 8 METs across DRILL and SCRIMMAGE activity during Session 1. Intensity was not quite as high during Session 2 but still averaged vigorous- and moderate-intensity, respectively, during DRILL and SCRIMMAGE conditions. Both athletes who used a manual wheelchair for ambulation sustained strictly moderate-intensity activity during all training bouts. Intensity remained above 3 METs during both DRILL and SCRIMMAGE activity but athletes with SCI did not sustain vigorous intensity during gameplay.

The metabolic findings are supported by HR data. As a percentage of maximum HR, the sample averaged intensities between 60 to 65 of maximum HR which was blunted by the lower heart rate responses among athletes with spinal cord injury. ACSM recommends 77% of maximum heart rate as a criterion for vigorous intensity exercise. Two athletes surpassed this benchmark during drill and game activity and the ACSM equation underestimates intensity in persons with SCI. It is clear that PTT provides a meaningful health and rehabilitation training stimulus as no players demonstrated an intensity lower than moderate.

Discussion & Conclusions

Findings in the current study support the ability of PTT to serve as a meaningful and effective exercise stimulus for individuals with mobility impairments. Specifically, participants sustained moderate- and vigorous-intensity training that meets the World Health Organizations' weekly physical activity guidelines of 150 minutes of moderate-intensity exercise OR 75 minutes of vigorous. In a study of 83 players, participants reported that they wanted to enhance their physical fitness and functioning through PTT sport [12]. We used two estimates of intensity, METs and HR, to triangulate a valid measure of activity intensity. Data in the current study demonstrate a clear exercise stimulus as metabolic and heart rate responses showed linear increases from rest (increase from rest to warm-up, warm-up to drills, warm-up to scrimmage) and concomitant decreases during cool-down. Therefore, findings from the current study support the ability of individuals to achieve meaningful fitness improvements through regular PTT participation.

Sport is an important, and often overlooked, physical activity setting. Individuals living with mobility impairments need sport options because these settings eliminate a number of barriers to physical activity. Specifically, PTT is one of a limited number of environments that are inclusive (same table, equipment) and accessible for this population [6]. In this regard, disability sport can contribute to a healthy lifestyle and overall injury prevention [16]. Individuals with mobility impairments participate in PTT for a variety of reasons, including the perceived impact on their quality of life, a sense of respect for themselves and their community, and a perceived ability to improve their physical functioning through exercise [12]. This study is one of the first to demonstrate that PTT can be used to improve fitness and meet physical activity

recommendations for improved health and morbidity reduction. This conclusion is supported by reductions in body weight following 90 days of PTT training among PTT players [16] and decreased body fatness following a semester-long TT intervention in able-bodied college students [17].

Table tennis intensity has a reported range of 4.0 METs in able-bodied participants to 2.7 among wheelchair users [7]. Based on the current findings, the estimates reported in the Compendium seem most likely to reflect recreational play. In the current study, standing PTT athletes sustained vigorous-intensity exercise across both days of DRILL (8 to 10 METs) and SCRIMMAGE (7 to 8) conditions. These values are higher than most disability sport demands with the exception of sit-skiing and wheelchair fencing. In the current study, wheelchair class participants averaged 4.2 to 3.6 METs across drill and scrimmage intensities, respectively. This energy demand is consistent with wheelchair tennis (4.1 METs) but slightly lower than wheelchair basketball (5.1).

It is also worth noting that intensity decreased slightly during SCRIMMAGE conditions compared to DRILLS. This change is explained by the intermittent rest that is part of gameplay. Whereas an increase in intensity is typically demonstrated from practice to scrimmage in continuous sports such as wheelchair tennis and rugby [8,18,19], the rally periods in PTT can be shorter than the rest periods. For instance, in wheelchair PTT players, rallies last from 3-5 seconds with rest time between 12-14 sec [14]. Hence, intensity declines from drills to scrimmage were not unexpected.

There are limitations to the current study. We only examined participants who are at the high end of sport performance and therefore have the skill to sustain rallies. It should be noted that less skilled players may not demonstrate the same activity intensity; therefore, future studies should examine the exercise intensity during recreational TT play among individuals with mobility impairments. A second limitation is the fatigue from wearing equipment reported from the players. The VO₂ Master is fairly lightweight but still has a cumulative effect on novice wearers. Intensities decreased slightly during day two of training and we are uncertain if these changes are due to affective (less adrenaline) or physiological (physical fatigue) factors across multiple days of equipment use.

In conclusion, PTT athletes were able to meet and sustain physical activity intensities recommended by the World Health Organization for positive health-related outcomes. PTT is considered to have a low injury risk among Paralympic sports [11]; therefore, this sport is a viable physical activity and rehabilitation option given its ability to transcend typical barriers for individuals with mobility impairments.

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